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Frequency of External Defect and Skidding Damage in Ponderosa Pine Stands in the Black Hills

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The average frequency of defect and skidding damage in eight ponderosa pine stands in the Black Hills was less than 8%. Forked tops and crook in the bole were the most common natural defects. Skidding damage was present in about the same frequency as forked tops and crook and was not related to residual growing stock level.

Keywords: Defect, harvesting damage, *Pinus pondersosa*

Defects generally reduce the volume of sound lumber or lower the structural properties of lumber derived from forest trees. Defects may render a tree useless for lumber depending on where they occur in the bole. A serious defect at either end of the bole may not significantly reduce the volume derived, while one in the center of the log may cull the entire log.

Defects result from several factors, including biotic agents, physical factors, growing conditions, genetic stock, and mechanical injury. During the development of the stand, mechanical injury is not important until the first thinning or harvesting operation. Until that time, nearly all defects originate from natural causes.

Biotic agents frequently cause crook, spikes, or dead tops. Insects, particularly tip moths and bark beetles, kill the leaders of young trees. After the leader is killed, a lateral branch assumes the role of the leader, but the vertical continuity of the bole permanently deviates from a relatively straight line. As the tree matures, a crook in the bole is evident. Porcupines may also cause crook by girdling the stem several feet below the leader, killing the stem above the girdle. In contrast to the insect-caused crook, a spike usually remains subtending from the crook.

Forked top trees and leaning trees may be caused by physical or genetic factors or growing conditions. The severity of defect in forked top trees depends on where the fork occurs in the bole. Forked top trees are also prone to damage by wind that may break off one of the forks. Leaning trees, commonly called leaners, grow relatively straight but at an angle from the normal vertical alignment.

This note presents information on the frequency of the various defects in stands of ponderosa pine (*Pinus ponderosa* Lawson) in the Black Hills.

Definitions

Forked top.—Forked top trees were defined as having a main bole that subdivided at some point above the base and, thereafter, supported two or more live crowns.

Multiple forked top.—Forked top trees in which one of the forks subdivided and supported two or more live crowns.

Dead top.—A tree with a live crown but a dead leader.

Sweep.—A gradual curvature of the main bole.

Leaner.—A tree with a bole not growing vertically.

Scar.—A place on the bole where the bark has been removed and the wood is exposed.

Crook.—An abrupt bend in the bole.

Spike.—A spike is a dead limb, usually the former live crown that has died, subtending from a crook in the bole.

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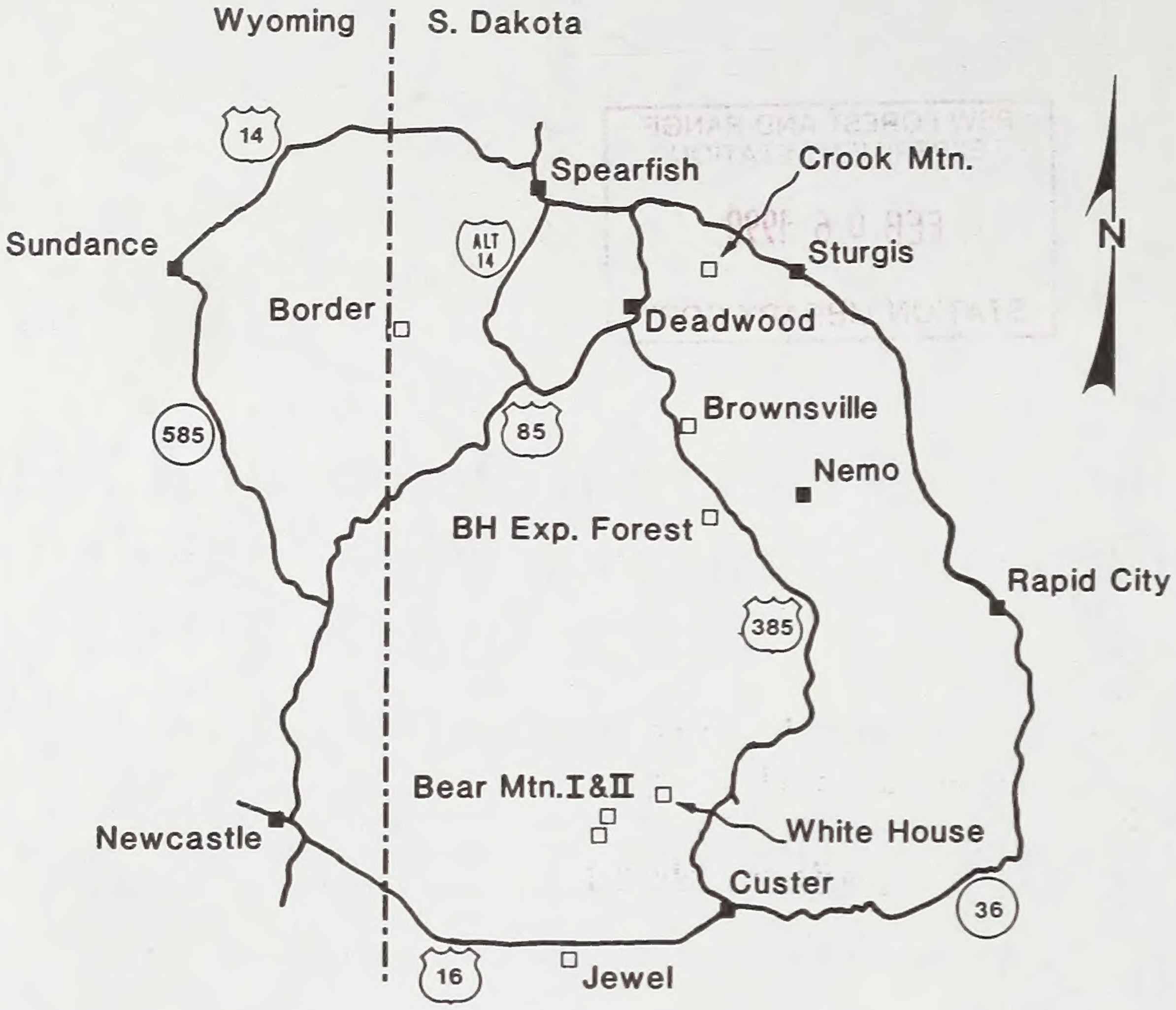

Figure 1.—Location of the surveyed stands.

Stand Conditions

The ponderosa pine stands were in the central and northern Black Hills (fig. 1). The stands were essentially pure pine with an occasional aspen (*Populus tremuloides* Michx.), white birch (*Betula papyrifera* Marsh), or white spruce (*Picea glauca* (Moench) Voss) present in some plots. Average stand diameter exceeded 8 inches d.b.h., and basal area was generally greater than 150 square feet per acre.

Methods

During installation of 2.5-acre plots investigating the relationship between different growing stock levels (GSL) and subsequent mountain pine beetle caused tree mortality, several tree defect characteristics were commonly recorded: forked top, dead top, sweep, lean, scar, crook, and spike. After the stands were cut to the designated GSL, a survey was conducted to determine the amount of felling and skidding damage as well as the cutting of designated leave trees. For skidding damage, each tree was inspected and classified into one of three classes based on the amount of bole area affected: I—less than 1 square foot of bark either removed or phloem exposed, II—1 to 3 square feet of bark either removed or phloem explosed, and III—more than 3 square feet of bark either removed or phloem exposed. Because the range of GSL's were not installed at every location, table 2 has no entries for those GSL's not installed. Two areas—White House and Jewel Cave—were installed in 1989 and were uncut when this paper was prepared.

Results and Discussion

The two most frequent defects were forked tops and crook (table 1). Forked tops were present an average of about 6.6% over all locations, but this average value was inflated because of the high incidence on the Jewel plots. Excluding the Jewel plots, the average frequency of forked tops was less than 5%. When multiple-forked tops were combined with single-forked tops, the forked top percentage averaged 7.7.

Crook was present an average of 5.8% over all eight locations. Crook was particularly noticeable in the southernmost plots. In the Bear Mountain locations where old, overmature trees taller than the general height of the stand were scattered throughout the plots, these trees may have caused previous leader damage on younger trees when they died and fell. The frequency of crook and spike was about equal because, generally, when crook is present, spike is present also. The biotic agents which kill the upper portion of the crown create the spike and crook at the same time.

Table 1.—Frequency (%) of defect characteristics by location.

Defect characteristic	Location Bear Mtn. I	Bear Mtn. II	Border	Browns-ville	Crook Mtn.	Black Hills Exp. Forest	White House	Jewel	Mean over all locations
Forked top	6.6	6.4	7.4	2.5	0.0	4.8	4.3	21.0	6.6
Multiple forked top	2.1	0.5	0.8	0.0	0.9	0.2	0.6	3.4	1.1
Dead top	2.4	2.6	2.4	0.5	0.5	0.4	0.6	3.5	1.6
Sweep	2.5	2.4	2.7	2.2	0.0	2.4	1.7	3.1	2.1
Leaner	1.4	0.7	2.4	0.5	2.2	1.6	3.6	1.9	1.8
Scar	0.6	0.7	3.3	0.3	0.8	3.3	1.0	0.6	1.3
Crook	9.6	4.3	3.5	2.6	0.3	3.1	11.1	11.9	5.8
Spike	9.7	2.5	1.3	1.1	0.1	2.6	5.9	8.3	3.9

Table 2.—Frequency (%) of skidding damage by GSL by location: I = less than 1 square foot; II = 1 to 3 square feet.

GSL	Location Bear Mtn. I[a]	Bear Mtn. II	Border[b]	Brownsville[b]	Crook Mtn.[b]	Black Hills Exp. Forest[b]
I						
40						7.2
60	2.8		6.6	1.3		3.0
80	3.9		3.6	2.6	5.4	5.6
100	5.4	NS	3.9	2.9	3.0	NS
120		NS			3.2	
140		NS				
II						
40						0.6
60	0		1.4	0		0.6
80	0		2.0	0	0.8	1.6
100	0	NS	0.4	0	0.0	NS
120		NS			0.4	
140		NS				

NS = Not skidded.
[a] = *Horse-skidded.*
[b] = *Mechanically-skidded.*

Two infrequently occurring defects were leaners and scars. The frequency of scars in the Border location was artificially high because of partial cutting in two of the plots prior to our surveys. Most of the scars resulted from skidding damage during the prior cutting activities.

Skidding damage was less than 8% in all locations and generally averaged between 2% and 5% across all GSL's for each location (table 2). Damage in horse-skidded locations was just as high as in mechanically-skidded locations. The real benefits of horse-skidding may be in the higher GSL stands. In the two horse-skidded locations, Bear Mountain I and II, the operator chose not to take the trees in the higher GSL stands; therefore, the potential advantages of horse-skidding could not be evaluated. Horse-skidding was less damaging because no Class II damage was created in the horse-skidded stands, whereas 0.4% to 2.0% of the trees suffered Class II damage in mechanically-skidded stands.

For the mechanically-skidded locations, skidding damage was greatest in the lowest GSL's in three of the four locations. This unexpected result reflects skidder operator's attitude and carelessness when operating in the stands. Considering the density of the residual stands, skidding damage in GSL 40 or GSL 60 stands should never exceed that of GSL 80 or GSL 100 stands.

Conclusions

The frequency of defect is relatively low in ponderosa pine stands in the Black Hills. Specific defects can generally be eliminated by judicious partial cutting, unless their incidence exceeds 10%. When the incidence exceeds 10%, some defect may have to be tolerated, particularly in the higher GSL's, because trees with defects have to be left to provide desired stocking and spacing. Skidding damage was also relatively low but could be lowered even further by stricter enforcement of logging contracts.

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